Anthropomorphic Response: Understanding Interactions Between Humans and Artificial Intelligence Agents

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AI is Everywhere
Ubiquity of Artificial Intelligence

- AI Voice Recognition
- AI Virtual Assistant
- AI Autopilot
- Recommendation Systems
- AI Physical Assistant

AI and Anthropomorphism

Anthropomorphism is defined as the “tendency to attribute human-like characteristics, motivation, intentions, or emotions on nonhuman agents” (Epley et al. 2007)

Definition of Anthropomorphism

Guthrie, 1993	**Seeing** the human in non-human **forms and events**, pervades human judgment
Nass and Moon, 2000	The assignment of **human traits and characteristics** to robots
Duffy, 2003	The **rationalization** of animal or system behavior through superposing aspects of the human observer
Epley 2007	Imbuing the imagined or real behavior of nonhuman agents with humanlike **characteristics**, **motivations**, **intentions**, and **emotions** is the essence of anthropomorphism" (pp. 864-865).
Bartneck, 2008	The attribution of a human **form**, human **characteristics**, or human **behavior** to nonhuman things
Kuchenbrandt et al., 2011	Imbuing the imagined or real behavior of nonhuman agents with humanlike **characteristics**, **intentions** and **emotions**

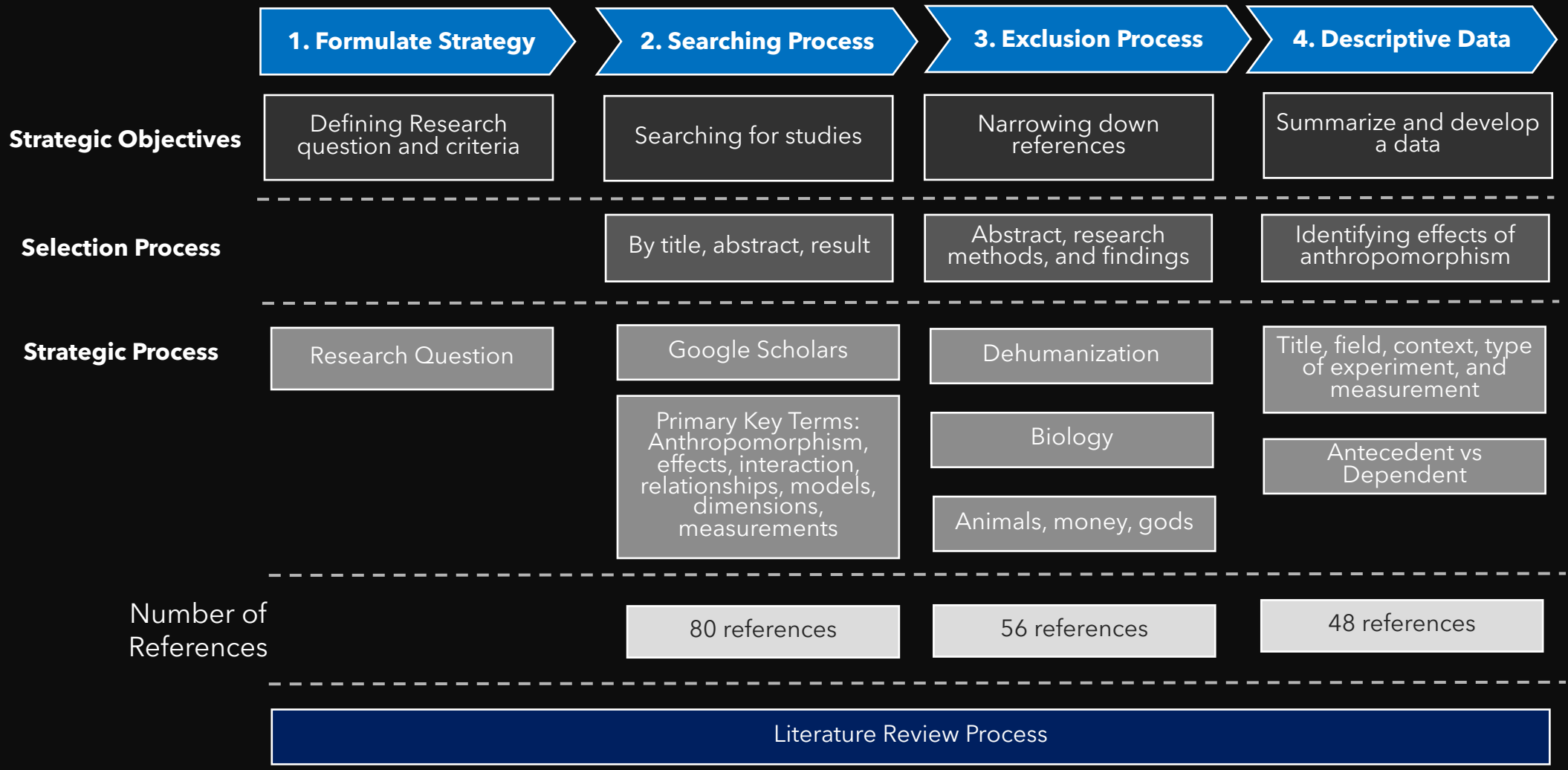
Anthropomorphism in AI is…. attributing human-like properties (form, characteristics, and behaviors) to build a relationship, sense of sharing, and involvement.

Research Questions

(R1) How does anthropomorphism in Artificial Intelligence differ from traditional technology?

- *Does anthropomorphism build on the perception of relationship through interaction and reciprocity with a non-human agent?*
- *What are the types of features (agent vs. observer) in anthropomorphism and how does the observer feature affect the relationship between the agent features and anthropomorphism?*

Literature Review Process



Conceptualization of Anthropomorphism

	Field	Author	Key Contribution	Anthropomorphism measures and details	Type
Dimensions of Anthropomorphism	HRI HCI	(Kahn et al. 2006)	Categories of interaction that capture conceptually fundamental aspects of human life	Autonomy, Imitation, Intrinsic Moral Value, Moral Accountability, Privacy, Reciprocity	Conceptual
	Robot Design	(Choi and Kim 2008)	Defining anthropomorphism in robot design	Appearance and Interaction, Cognitive Response, Humanness	Conceptual
	HRI	(Złotowski et al. 2015)	Human-likeness is multidimensional set of parameters.	Appearance, Behavior	Conceptual
	Automation Science and Engineering	(Zhang et al. 2008)	Research framework for robot and the human user in the context of service application	Physical appearance, Interface features (facial expression, voice capability, user interaction)	Conceptual
	Consumer Psychology	(Yang et al. 2020)	Identifying three dimensions of anthropomorphism by applying naïve theories of human behavior	Three dimensions, Connection, Comprehension, Competition	Conceptual
Cognitive Process of Anthropomorphism	HCI	(Lemaignan et al. 2014)	Stages of anthropomorphism and cognitive interpretations	Stages: Initialization, Familiarization, stabilization	Conceptual
	HCI	(Powers and Kiesler 2006)	Differences in people's mental model of robots	Human likeness, Machine likeness, Knowledge, Sociability, Masculinity, Dominance	Empirical
	Cognitive Psychology	(Waytz et al. 2013)	Anthropomorphism arises when triggered	Similarity, Knowledge and Experience, Sense-making	Conceptual
	Psychology	(Epley et al. 2007)	Three Factor Analysis on Anthropomorphism	Elicited agent, Sociality motivation, Effectance motivation	Conceptual
	HCI	(Lee et al. 2005)	Importance of social cues and information use to create mental models	Automation response to social cues and information	Empirical
Measurements of Anthropomorphism	HRI	(Bartneck et al. 2009)	Proposing Godspeed questionnaire	Natural/Fake, Machinelike/Humanlike, Unconscious/Conscious, Artificial/Lifelike Moving rigidly/elegantly	Conceptual
	HCI	(Ruijten et al. 2019)	Explore a new method for measuring anthropomorphism, based on the Rasch model.	Rash Model	Empirical
	HRI	(Carpinella et al. 2017)	Develop RoSAS to measure people's judgments of the social attributes of robots.	The Robotic Social Attribute Scale with 18 item scales	Empirical
	Computers in Human Behavior	(Ho and MacDorman 2010)	Developing and validating an alternative to the Godspeed indices	The new humanness and eeriness indices facilitate plotting relations among rated characters of varying human likeness.	Empirical

Dimensions of Anthropomorphism

Agent Feature

User Feature

Author	Dimensions	Variables	Measurements
Molly	Observer Features	Cognitive	Agent knowledge, mind attribution, mental states
		Motivation	Effectance, Sociality
	Agent Features	Behavior	Predictability, Negative Consequences, Motion patterns
		Appearance	Similarity to humans, Design type (functional and biologically inspired)
Epley	Psychological determinants	Elicited agent knowledge	Need for cognition, perceived similarity, acquisition of alternative theories, experience, norm, ideologies
		Effectance motivation	Need for closure, desire for control, anticipated Interaction, apparent predictability, attaining competence, uncertainty avoidance
		Sociality motivation	Desire for social contact and affiliation
Zlotoski	Uniquely Human		Broadminded, humble, organized, polite, thorough, cold, conservative, hard-hearted, rude, shallow
	Human Nature		Curious, friendly, fun-loving, sociable, trusting, aggressive, distractible, impatient, jealous, nervous
Waytz	Stable Behavioral Tendencies	Individual Differences in Anthropomorphic Questionnaire	Intention, free will, emotion, good-looking, consciousness, mind of its own, durable
Zitzewitz	Human Likeness	Appearance	Visual Appearance, Sound, Smell, Haptic Appearance, and Taste.
		Behavior	Movement, Interactive Behavior, Social Behavior, Verbal Communication, and Nonverbal Communication.
Power and Kiesler	Appearance	Physical Attributes	Sociability, knowledge, dominance, human-likeness, masculinity, machine likeness
Eyssel	Traits	Human nature	Curious, Friendly, Aggressive, Distractible, Impatient, Jealous, Nervous
	Emotions	Primary Emotions	Excitement, Joy, Surprise, Happiness, Pleasure Anxiety, Fear, Pain, Sadness, Anger
		Secondary Emotions	Love, Hope, Passion, Emotion, Admiration Contempt, Guilt, Shame, Bitterness, Spitefulness
Gray	Agency		hunger, fear, pain, pleasure, rage, desire, personality, consciousness, pride, embarrassment, and joy.
	Experience		Self control, morality, memory, emotion recognition, planning, communication, and thought.

Agent Features of Anthropomorphism

Appearance **Movement** **Intelligence**

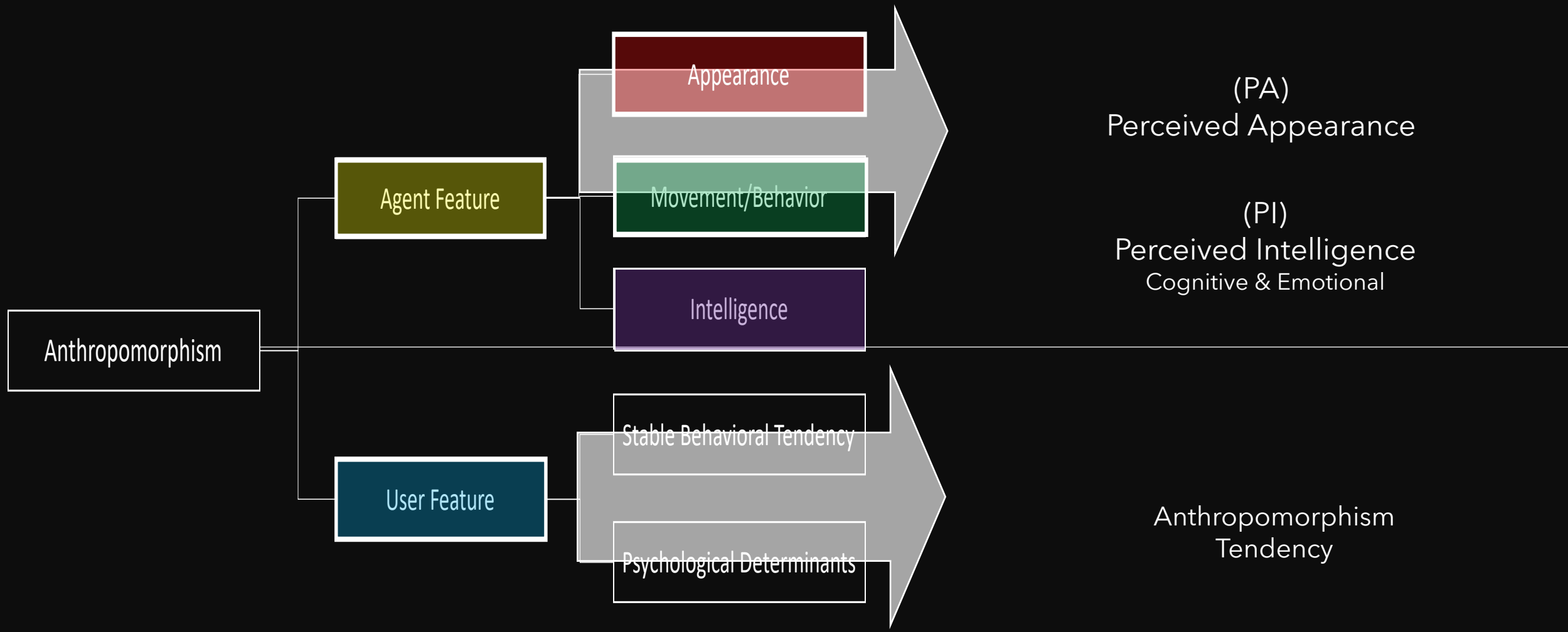
Author	Context	Device	Degree	Features	Measure-ment	DV	Result
(de Visser et al. 2016)	Advising TNO Trust Task	Screen (agent)	Human Avatar Computer	Appear-ance	Godspeed question-naire	Trust	Positive
(Goudey and Bonnin 2016)	Reactions of mothers	Robots	Emox (low)	Anatomical differences	Godspeed question-naire	PU	No Effect
			PaPeRo (Medium)			PEOU	
			Nao (High)				
(Salem et al. 2013)	Interactive robot	Honda humanoid robot	None	Speech gestures	Haslam et al.'s list of human nature traits	User experience	Positive
			gestures			HRI	Positive
(Natarajan and Gombolay 2020)	Helper in interactive math quiz	Machine and robot	Pepper (High)	Appearance and four behaviors	Godspeed question-naire	Trust	Positive
			Nao (High)				
			Sawyer (Medium)				
			Kuri (low)				
(Waytz, Epley, et al. 2010)	Health predict	Machine and robot	Technical agent	Appear-ance	IDAQ	Moral Care and Concern	Positive
	IBM's chess-playing Game		Nonhuman stimuli			Responsi-bility and Trust	Positive
	Computer interface		Anthropom-orphized robot Kismet			Social Surveil-lance	Positive
(Syrdal et al. 2013)	HRI	Compa-nion robot	Medium	Expressive cues and mobility	Godspeed question-naire	Relation-ship	Positive
(Ahmad et al. 2019)	HRI	Machine and Robot	Husky	Error-rate	Godspeed question-naire	Trust-worthy	No effect
			Pepper				
(Pinxteren et al. 2019)	Services Marketing	Service Humanoid	Medium	Changing eye color	Godspeed question-naire	Trust	Positive
(Liu et al. 2019)	Patient and a robot trainer	Machine and Robot	Three levels of anthropo-morphic appearance	Facial expressions and gestures	(Choi and Kim 2008)	PEOU	No Effect
						PU	
						BI	
						Subjective Norm	
						PU	
(Shim and Lee 2020)	Consumer-brand relation-ships	Advertise-ment	Low	Appearance	IDAQ	Brand Attitude	Positive
			High			Purchase Intention	

Agent Features of Anthropomorphism (Cont'd)

Appearance **Movement** **Intelligence**

Author	Context	Device	Degree	Features	Measure-ment	DV	Result
(Rietz et al. 2019)	Chatting Screen	Chat-bot	Functional (Short pause and emoji)		Slack API document-tation	PU	Positive
						PEOU	Positive
						Enjoyment	No Effect
			Design (Picture and name)			PU	No effect
						PEOU	
						Enjoyment	Positive
(Yogeeswaran et al. 2016)	Survey	Screen-shot of robots	NAO robot (low)	Appear-ance		Realistic Threat	Negative
			Geminoid (High)	Capability		Identity Threat	Negative
(Bartneck et al. 2010)	Experiment in healthcare examination	Machine and robot	Technical box	Appear-ance and voice		Embarr-assment	Negative
			Technical robot				
			Lifelike robot				
(Riek et al. 2008)	Empathy expressed	Film clips of humanoid	Five degrees of human-likeness	Appearance and Acting		Empathy	Positive
(Syrdal et al. 2013)	HRI	Compa-nion robot	Medium	Expressive cues and mobility	Godspeed question-naire	Relation-ship	Positive
(Hur et al. 2015)	Consumer Purchase	Cookie and TV gadget	Low	Human face		Confliction	Negative
				features and talking			No Effect
(Wan et al. 2016)wa	Consumer Preference	Appliances	Anthropomorphized product	Human faces and introduce-tion	Appearance Function	Search for informa-tion	No Effect
			Non-anthro				
			landscape				
			baseline				
(Kim et al. 2020)	Consumer-brand relation-ships	Fan page	Anthro vs. non-anthro	Profile picture and introduc-tion in first person		Brand Attitude	Positive
(Adam et al. 2020)	Artificial Intelli-gence	Chatbot	High	Verbal anthropo-morphic design cues		Social Presence	Positive
						User Compli-ance	

Research Model Dimension



Literature Review (Anthropomorphism Tendency)

Anthropomorphism does not occur to an equivalent degree across individuals.

Individual difference: differences in culture, norm, experience, education, and cognitive reasoning styles may affect how individual anthropomorphize the non-human agents. To understand how situational, biological, and cultural factors work in concert to create reliable individual differences in anthropomorphism. (Waytz, Cacioppo, Epley 2010)

Individual Differences in Anthropomorphism Questionnaire (IDAQ)
It involves a 15-item questionnaire that assesses anthropomorphism (e.g., attributions of consciousness, intentions, emotions) of technologies, inanimate nature, and animals. It has been found to have high internal consistency ($\alpha \geq .82$) and stability over time.

General behavioral anthropomorphic tendency across all nonhuman targets: animals, technology, and nature

Questionnaire (9 questionnaire, 3 groups)

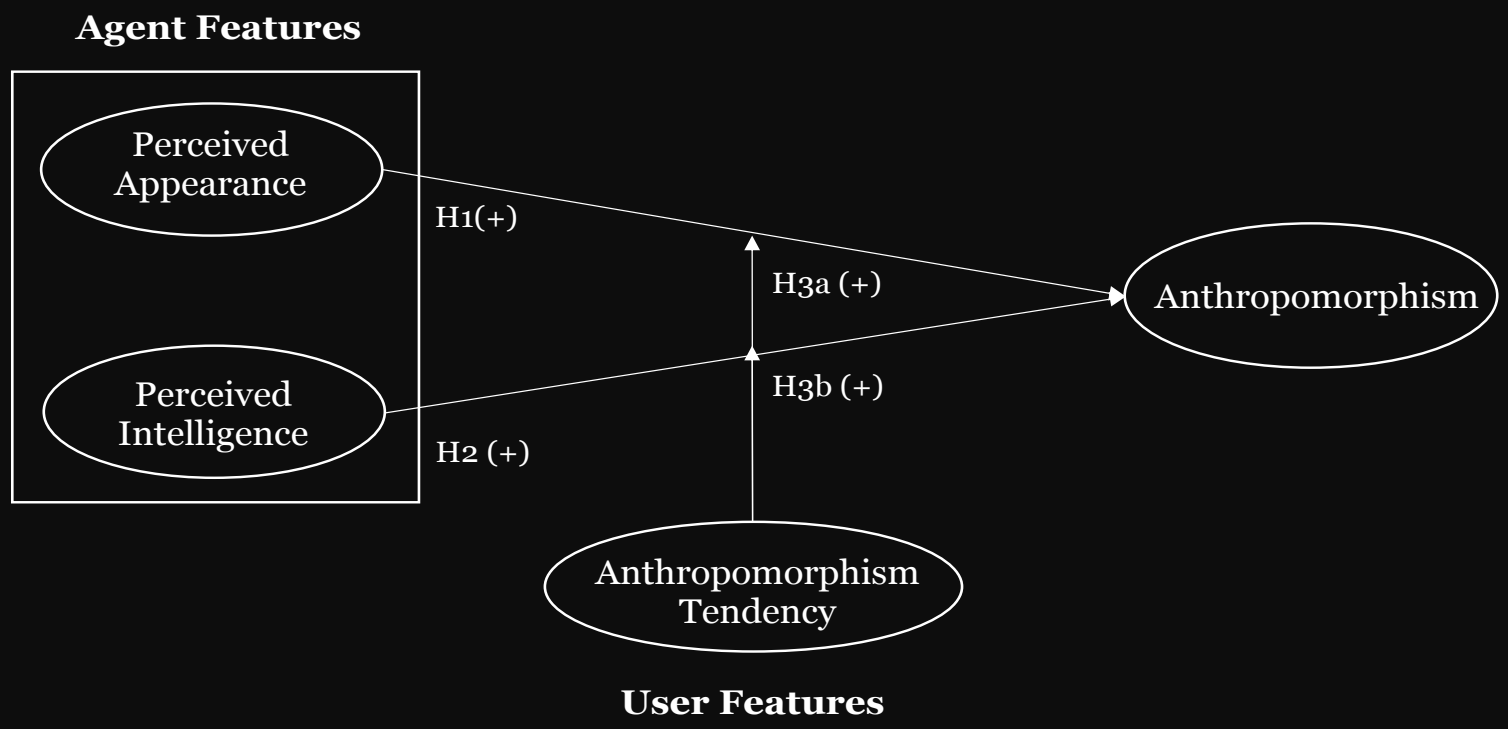
- By “has a mind of its own” we mean able to do what it wants.
- By “has free will” we mean able to choose and control its own actions.
- By “has intentions” we mean has preferences and plans.
- By “can experience emotion” we mean it has feelings.
- By “has consciousness” we mean able to be aware of itself and its thoughts/feelings.
- By “good-looking” we mean attractive.
- By “lethargic” we mean moving slowly.
- By “active” we mean moving frequently and quickly.
- By “useful” we mean able to be used for something.

Literature Review (Anthropomorphism Tendency)

Previous Studies

Author	Purpose	Result
Hortensius et. L. 2021	To measure dispositional anthropomorphism (relationship between anthropomorphism and theory of mind)	No relationship between situational or dispositional anthropomorphism and general theory-of-mind was observed.
Kamide and Arai, 2017	To control individual attributes (comfortableness)	IDAQ has significant effects for comfort, performance, peace of mind, controllability.
Złotowski et al. 2014	To ensure that participants did not differ in their general tendency to anthropomorphize (dimensions to humanness)	Confirmed with 2-way ANOVA that there is no interaction effects between IDAQ and experimental conditions on measurements of two-dimensional anthropomorphism
Złotowski et al. 2018	To measure individual difference (media equation effect to robots)	IDAQ had no statically significant effect on dependent variables
Marchesi et al., 2021	To measure individual level (Adopting intentional stance towards robot)	High level of anthropomorphism is associated with a high tendency to adopt the intentional stance.
Sandoval et al., 2016	To measure individual difference (How body postures influence human-robot proximity)	No statistically significant effect on the distance

Research Model



H1. Perceived Appearance (PA) positively affects Anthropomorphism

H2. Perceived Intelligence (PI) positively affects Anthropomorphism.

H3a. Anthropomorphism tendency positively moderates the relationship between PA and anthropomorphism.

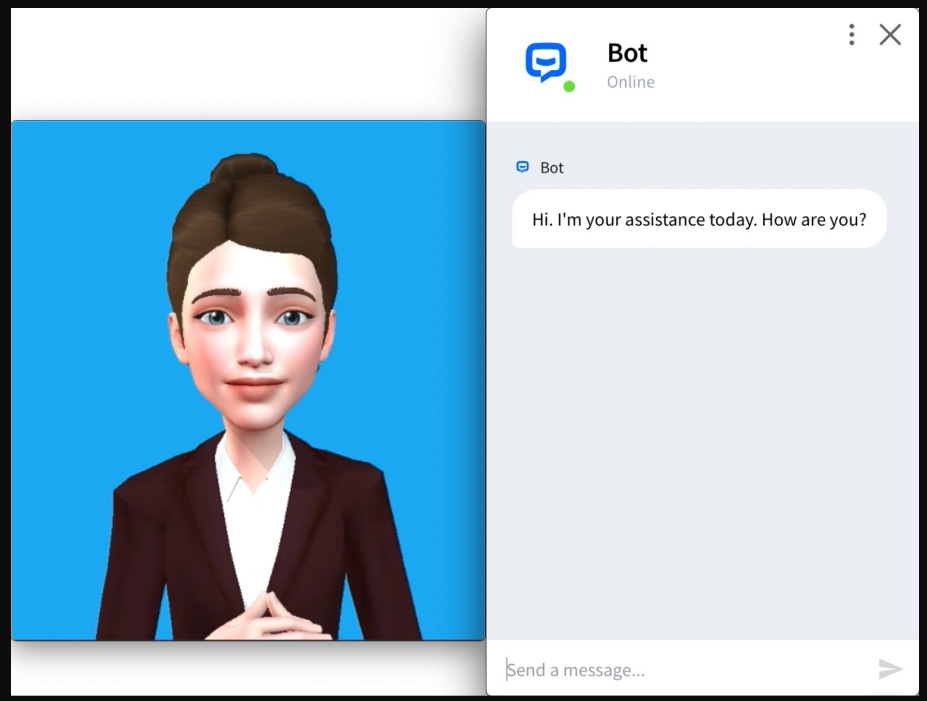
H3a. Anthropomorphism tendency positively moderates the relationship between PI and anthropomorphism.

Study Design: Survey

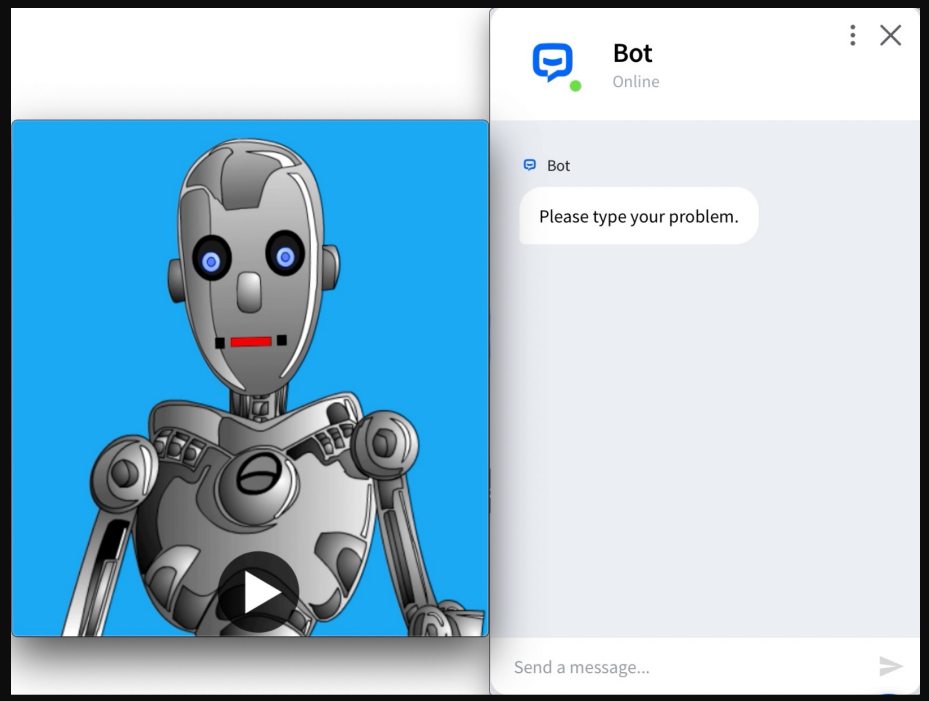
Participants gathered for **4** different scenarios for the Perceived Appearance (PA) and Perceived Intelligence (PI) variations

	High Perceived Intelligence	Low Perceived Intelligence
High Perceived Appearance	High PA + High PI	High PA + Low PI
Low Perceived Appearance	Low PA + High PI	Low PA + Low PI

1. Study Explanation → **2. Pre-survey** → **3. 4 Scenarios** → **4. After-Survey**

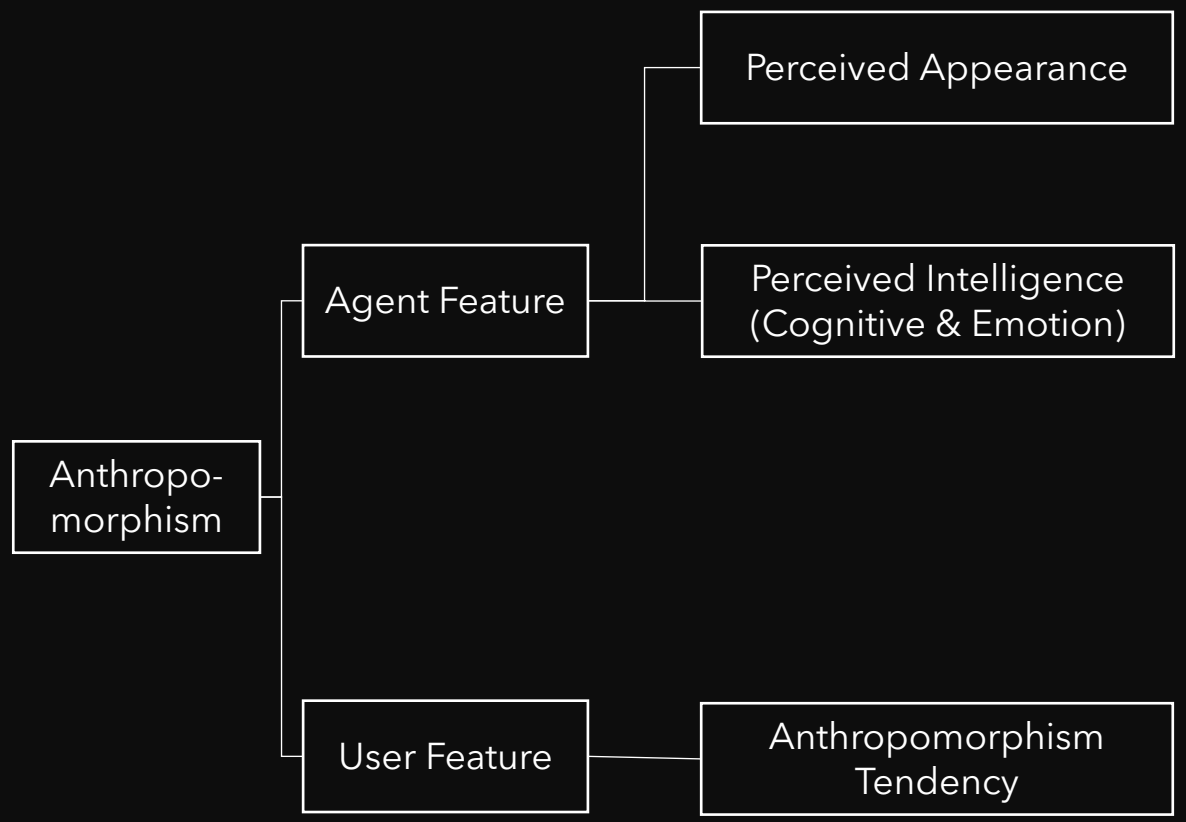


High PA + High PI



Low PA + Low PI

Measurements



Bartneck 2009

Natural/Fake
Machinelike/Humanlike
Artificial/Lifelike
Moving rigidly/elegantly
Unconscious/Conscious

Moussawi and Koufairis 2019

1. The IA can complete tasks quickly.
2. The IA can understand my commands.
3. The IA can communicate with me in an understandable manner
4. The IA can find and process the necessary information for completing the tasks.
5. The IA is able to provide me with a useful answer.

Pant2. The personal intelligent agent can be happy (PA2)
Pant3. The personal intelligent agent can be friendly (PA6)
Pant4.The personal intelligent agent can be respectful (PA7)
Pant5.The personal intelligent agent can be funny (PA8)
Pant6.The personal intelligent agent can be caring (PA9)

Epley et al. 2007

By “has a mind of its own” we mean able to do what it wants.
By “has free will” we mean able to choose and control its own actions.
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Measurement Development

Anthropomorphism

New measurement needed:
1. Conceptual Development and Initial Item Generation
   - adapted relevant measures in the literature
   - confirmed and modified

2. Conceptual Refinement and Item Modification
   - sorting procedure etc.
   - pilot test 1
   - Final refinement

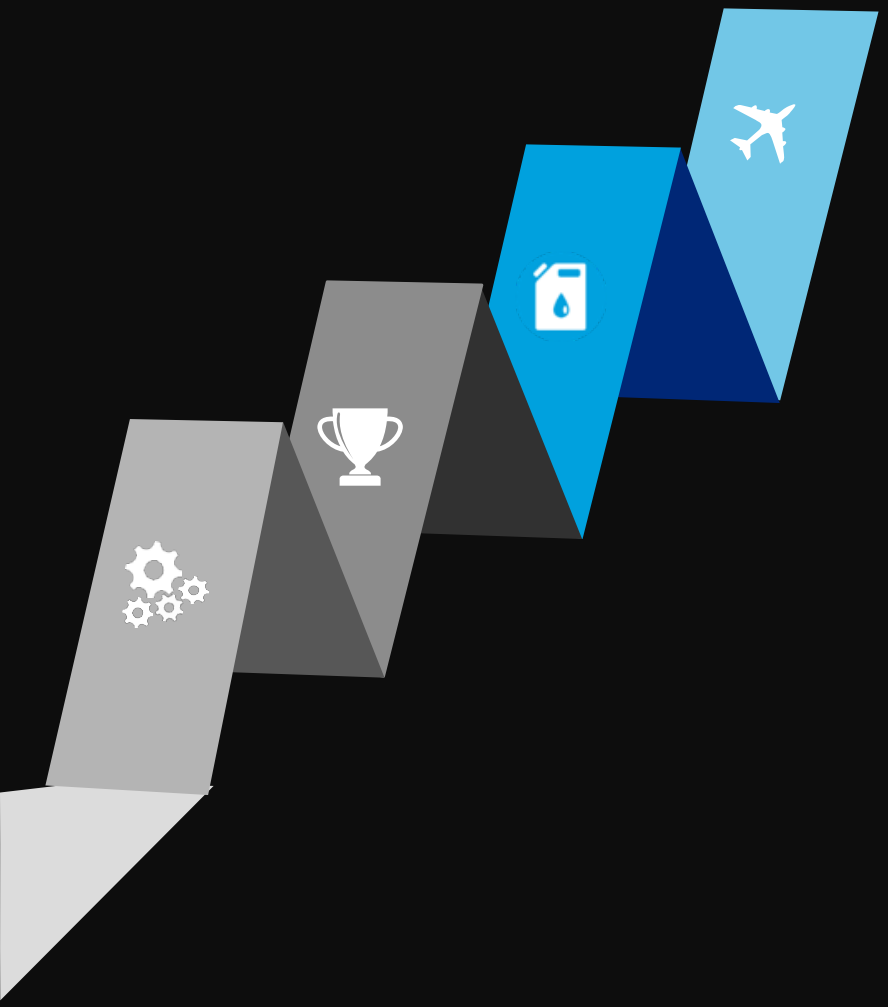
3. Survey Data Collections

4. Data Analysis and Measurement Validation
   - Data Screening and Descriptive Analysis
   - Confirmatory Factor Analysis
   - Factorial Invariance analysis
   - Nomological validity

- ✓ Developing a formative scale to measure consumers' trust toward interaction with artificially intelligent (AI) social robots in service delivery
- ✓ Social Skills Inventory (SSI)
- ✓ Self-disclosure and interpersonal solidarity: Measurement, Validation, and Relationships
- ✓ The Chatbot Usability Scale: Design and Pilot of a Usability Scale for Interaction with AI-Based Conversational Agents

I am willing to build a relationship with the chatbot agent.
I feel I am understood by the chatbot agent.
I am willing to share my personal information with chatbot agent.
I think the chatbot agent is responsive.
I think the chatbot recognize my needs.
I think the chatbot is reliable in performing
I think chatbot manages to surroundings
I think chatbot can feel emotions
I think chatbot can share emotions
I feel close to chatbot agent
I feel sense of sharing
I feel sense of involvement

Expected Contributions



Contributions

•Introduces a new scale for measuring anthropomorphic responses, emphasizing cognitive and emotional intelligence.
•Cognitive and emotional intelligence have a significant impact on anthropomorphic responses, surpassing appearance.
•Individual propensities like anthropomorphism tendencies (AT) can negatively affect responses, especially with highly intelligent and human-like AI agents.
•Offers practical implications for AI designers and managers to focus on intelligence over appearance and consider target audience characteristics.

Limitation

✓ Gender, ethnicity, context, various setting
✓ One-time interaction, long-term effects on anthropomorphism

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